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### ④ A damper, in particular as utilized in washing machines.

⑤ The damper (1) essentially comprises a cylinder (2) and, internally of the cylinder, a reciprocating piston (3) marginally smaller and substantially similar in overall section, of which the peripheral face presents a pair of annular projections (6, 7) serving to establish a seating (8) for an annular friction element (9) placed in direct contact with the inside wall of the cylinder (2); for operating purposes, the axial dimension (D1) of the seating (8) compassed by the two annular projections (6, 7) is greater than the axial dimension (D2) of the annular friction element (9) such that the damper produces a variable response in its dissipation of kinetic energy, the curve being determined by the difference (d $\varnothing$ ) between the external diameter ( $\varnothing$ e) of the piston (3) and the internal diameter ( $\varnothing$ i) of the cylinder (2), and by the degree of relative axial motion between piston and cylinder.

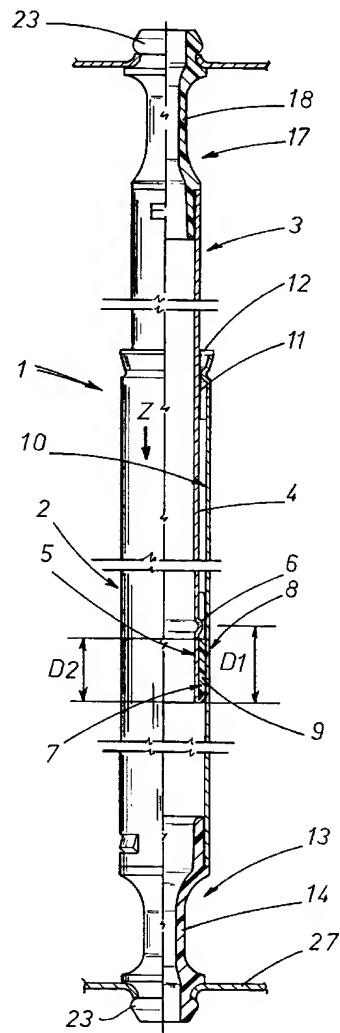


FIG 1

The present invention relates to a damper, in particular as utilized in washing machines. Conventionally, the drum of a washing machine, i.e. the substantially cylindrical and rotatable pierced container into which soiled clothes and linen are placed for laundering, is supported by telescopic dampers (more exactly, the drum and wash tank are suspended as a complete assembly, though reference is made simply to a "drum" throughout the present specification, in the interests of brevity). Such dampers are able to fulfil a need which arises in particular at the initial stage of the high speed "spin" part of the washing cycle, namely, to absorb vibrations that would otherwise be transmitted with notable intensity to the drum, hence to the entire machine, by reason of the masses which are set in motion during this transient state.

The dampers fitted to washing machines currently in production consist essentially in a cylinder, and a piston capable of axial movement internally of the cylinder. The cylinder and the piston each present a free end for connection respectively to the drum and to the frame of the washing machine.

So-called friction dampers of the type in question, for example as disclosed in IT 1 133 258, comprise an annular friction element interposed between the cylinder and the piston, of which the purpose is to absorb oscillations and vibrations which the drum would otherwise be forced to describe in relation to the washing machine, especially during certain stages of the machine's operation. The use of this type of suspension is recommended principally by the fact that the damping action can be maintained steady over time in proportion with the amount of energy to be dissipated.

The annular friction element is restrained axially in relation to the piston between two profiles or stops afforded by the piston itself; these project radially from a portion of the peripheral surface that remains permanently within the compass of the cylinder, such that with the drum set in rotation, the annular friction element is invested constantly with axial movement as one with the piston, sliding repeatedly against a corresponding portion of the internal surface of the cylinder.

It has been observed that this persistent sliding action, generated with the damper absorbing energy at an appreciably high rate, is eminently desirable during the initial stages of the high speed spin part of the wash cycle (in effect, during vigorous transient motion), though by no means advantageous once the initial stage of the spin is over. It will be common knowledge in fact that the initial stage of the spin in a machine wash cycle is typified by an energetic bouncing motion, with the drum turning noticeably off balance, whereas the remaining part of the spin is much smoother, as the drum rotates on its axis generating only marginal vibrations. These lesser vibrations would be better controlled if the dampers in

question were able to effect a reduced damping action during smoother and steadier rotation of the drum. In short, a preferred damper would be one of which the energy absorbing action can be varied to suit the stroke.

Accordingly, the object of the present invention is to provide a damper of the type described such as will absorb vibrations generated through the drum of a washing machine to optimum effect, that is, proportionately to the demands of the moment in any given operating condition of the machine.

An addition object of the present invention is to provide a telescopic damper of particularly simple and economical embodiment.

The aforementioned objects are realized in a damper according to the present invention, which is of the type as utilized in particular in washing machines, comprising a cylinder, and a relative piston of which a lateral peripheral portion affords at least two annular projections establishing a seating to accommodate at least one annular friction element offered in direct contact to the inside wall of the cylinder, and is characterized in that the axial dimension of the seating compassed by the annular projections is greater than the axial dimension of the annular friction element.

The invention will now be described in detail, by way of example, with the aid of the accompanying drawings, in which:

- fig 1 is the schematic side elevation of a damper according to the present invention, seen partly in section and connected to two components of a user appliance;
- fig 2 is a graph illustrating the variations over time, during operation of a damper as in fig 1, of the reaction force "F", a characteristic operating parameter of the damper;
- figs 3, 4 and 5 are enlargements of a detail of fig 1, viewed in section and with certain parts omitted better to reveal others, illustrating an annular area of the damper and a friction element, accommodated by the annular area, during different stages of the damping action;
- figs 6 and 7 show two alternative embodiments of a damper according to the invention, enlarged and in section, and with certain parts omitted better to reveal others.

In fig 1 of the drawings, 1 denotes a telescopic damper, in its entirety, of which the components directly engaged in absorbing kinetic energy are a cylinder 2, and a relative piston 3 consisting in a rod 4 of section matched approximately to that of the cylinder 2, of which the piston end 5 exhibits a pair of annular projections 6 and 7 designed to afford a stable seating 8 for an annular element 9 functioning as a means of frictional contact with the inside wall 10 of the cylinder 2.

With the damper in operation, the two annular

projections 6 and 7 remain spaced apart one from the other by a distance greater than the axial dimension of the annular friction element 9, such that the friction element 9 is capable of axial movement within the compass of the seating 8. 11 denotes a capping element associated with the cylinder 2, which is matched in shape to the rod 4 and affords a plurality of notches (one only of which, denoted 12, is illustrated in fig 1) such that when inserted into the marginally splayed end of the cylinder 2, a crimping force applied to the cylinder 2 over the notches 12 will ensure that the capping element 11 is held in a stable position. This same element also serves as a stop limiting the stroke of the rod 4.

The free ends of the cylinder 2 and the piston 3, denoted 13 and 17 respectively, are associated with relative shanks 14 and 18 (fashioned from flexible material in the example illustrated) of which the extremities afford anchor means 23 in the form of projections such as will snap into corresponding holes offered by the walls 27 of the two parts from which it is wished to absorb oscillations, (in the case of a washing machine, the drum and the frame). These components are not central to the present invention and therefore not described further. It will be seen that, by proportioning the annular seating 8 created between the annular projections 6 and 7 with an axial dimension D1 greater than the corresponding axial dimension D2 of the annular friction element 9, it becomes possible, as visible also from the graph of fig 2, to optimize the force opposing the axial movement of the piston 3 inside the cylinder 2 at any given moment during operation of the washing machine, i.e. during rotation of the drum, as friction is generated between the annular element 9 and the respective internal and external surfaces of the cylinder 2 and the piston 3.

In other words, a variable response can be achieved in the dissipation of kinetic energy, according to the difference  $d\emptyset$  between the external diameter  $\emptyset_e$  of the piston 3 and the internal diameter  $\emptyset_i$  of the cylinder 2 and to the relative axial travel between these same two components.

As indicated in figs 3 to 7, the annular projection denoted 6 consists in an annular boss 30 issuing from the peripheral surface of the piston 3, shaped and proportioned such that the extremity of the projection is recognizable as a restraining lip. Further to the aforementioned facility of varying the degree of response in the dissipation of energy by modifying the construction of certain parts of the damper, fig 6 shows an embodiment in which the peripheral part of the piston 3 occupied by the seating 8 exhibits an angled portion 8p, coinciding with the annular projection denoted 6; this creates a spoon-like profile in which to seat the annular friction element 9, and as a result, increases the difference  $d\emptyset$  between diameters referred to above. In like manner, fig 7 shows an em-

bodiment in which the annular dimension of the friction element 9 is dissimilar to the virtual annular dimension of the seating 8, such that the mean diameter  $\emptyset_{9m}$  of the friction element 9 differs from the corresponding mean diameter  $\emptyset_{8m}$  of the seating 8; thus, with the damper in operation and the friction element 9 compressed in the seating 8, a varying response is achieved in the dissipation of kinetic energy as the piston 3 and cylinder 2 are invested with axial motion relative one to the other. In this instance, the difference in response consists in a greater friction on the internal surface S2 of the cylinder 2 than on an external surface S3 of the piston 3 (these two variations in response are illustrated in the graph of fig 2, where the first is shown in broken line, and the second in dot-dash).

A further variation in response is obtainable by interposing a membrane 31 of compact dimensions, fashioned in material having a low coefficient of friction, between the external surface S3 of the piston 3 and the corresponding internal surface 9a of the annular friction element 9, in such a way as to reduce the effect of friction generated between the two; such a membrane 31 might consist in a film of paint applied to either of the two surfaces 9a or S3 in question, or alternatively, an ultra-thin layer of material fixed to one of the surfaces 9a or S3 by means of an adhesive.

In fig 2, which illustrates the spin stage of a machine wash cycle, the "x" axis represents the axial travel of the piston 3 within the cylinder 2, in millimetres, whilst the "y" axis represents the force of opposition to these same axial movements of the piston within the cylinder, in kilograms, resulting from the friction generated between the annular element 9 and the respective internal and external surfaces of the cylinder 2 and piston 3. Observing fig 2, in conjunction with figs 1, 3, 4 and 5, it will be seen how at the instant in which the piston 3 is driven by the drum toward the far wall 27 (arrow Z), the annular friction element 9 is positioned against the projection denoted 7 and the force "F" opposing the movement of the piston 3 into the cylinder 3 increases, rapidly at first, from zero (the position reflected in fig 3) to a value "A" which corresponds to the reaction force deriving from the friction generated in opposition to the sliding movement of the piston 3 within the annular friction element 9. The moment that the reaction force "F" reaches value "A", the piston 3 begins stroking at a substantially constant value of "F" internally of and in relation to the annular friction element 9, which remains substantially in the same position with respect to the cylinder 2 by reason of the greater degree of friction generated between the larger diameter surfaces of these same two elements. As the remaining projection 6 enters into contact with the annular friction element 9 (the position shown in fig 4), the element 9 is driven forward, thus sliding against the in-

ternal surface of the cylinder 2. The initiation of this sliding movement is accompanied by a sharp increase in the reaction force "F" to the value denoted "B", whereupon the force stabilizes during the entire subsequent duration of the sliding contact between the annular friction element 9 and the internal surface of the cylinder 2 (the position shown in fig 5).

As the piston 3 begins to stroke 2 in the opposite direction to that considered thus far, the factors already expounded above (which require no further repetition) will occasion an initial variation in the reaction force "F", which assumes value "-A" and thereupon stabilizes for a given period before undergoing a further sharp variation to the value denoted "-B", followed by a further stabilization, and finally a return to value zero, which occurs when the piston 3 reaches its position of maximum separation from the wall 27 of the frame.

From the foregoing, it will be seen that setting the annular projections 6 and 7 apart the one from the other by a distance greater than the axial dimension of the annular friction element 9 has a distinct effect, namely: each time the piston 3 is caused by the drum to penetrate further into the cylinder 2, or during the corresponding inverse movement, there will be an initial sliding movement of the piston 3 within the cylinder 2, occurring in conditions of relatively low friction, followed by a continuation of this same movement during which friction increases. During the initial stage of the spin effected by a typical washing machine (when the degree of relative motion between piston and cylinder is appreciable), the part of the stroke 3 that occurs at low friction brings no disadvantage, whereas the vibration-damping function proper is performed principally during the part of the stroke which occurs in conditions of higher friction, as appropriate; once beyond the transient state of the spin, which is characterized by strong vibrations, and with the oscillations of the drum significantly reduced, the damper 1 begins absorbing shock at a lower level of kinetic energy in accordance with the stated objects, without the reaction force "F" exceeding the value denoted "A", that is, with the piston 3 simply stroking against the inner wall of the annular friction element 9 and with no sliding contact produced between the annular element 9 and the cylinder 2. Thus, the damping effect is less pronounced and the suspension contributes (through a reduced reaction force) to a lower overall level of vibration.

No limitation is implied in the present disclosure; for example, the diameter of the piston 3 might be varied at the design stage to the end of varying the damping force during the initial stage of the spin, i.e. the value denoted "A" in fig 2, to suit different requirements of use.

## Claims

1) A damper (1), in particular as utilized in washing machines for absorbing the oscillations generated between two structures capable of relative motion such as a drum and a frame, of the type comprising a cylinder (2) and a relative piston (3), means (9) operating between the cylinder and piston of which the function is to dissipate the kinetic energy deriving from relative axial movements, means (23) associated with the free end of the cylinder and the free end of the piston, by which the damper is anchored to respective walls (27) afforded by the two structures capable of relative motion, and at least two annular projections (6, 7) associated with a peripheral portion of the piston (3), of which the function is to create a seating (8) for an annular friction element (9) offered in direct contact to the inside wall of the cylinder (2) and constituting the energy dissipation means (9), characterized,

5 in that, with the damper in operation, the seating (8) compassed by the two annular projections (6, 7) exhibits an axial dimension (D1) greater than the corresponding axial dimension (D2) of the annular friction element (9), in such a way as to achieve a variable response in the dissipation of kinetic energy which is dependent upon the difference (dØ) between the external diameter (Øe) of the piston and the internal diameter (Øi) of the cylinder, and on the length of the axial stroke effected by the piston and cylinder one in relation to another.

10 2) A damper as in claim 1, wherein at least one of the annular projections (6) associated with the piston (3) consists in an annular boss (30) issuing from the peripheral surface.

15 3) A damper as in claim 1, wherein the part of the peripheral portion of the piston (3) occupied by the seating (8) exhibits an angled portion (8p), positioned to coincide with one of the annular projections (6), such that the seating (8) assumes a profile of substantially spoonlike geometry in which to accommodate a relative annular friction element (9), and the value of the difference (dØ) between diameters is thus increased.

20 4) A damper as in claim 1, comprising an annular friction element (9) of which the annular dimension is dissimilar to the virtual annular dimension of the seating (8) and the mean diameter (Ø9m) is different to the corresponding mean diameter (Ø8m) of the seating (8), such that with the damper in operation and the friction element (9) compressed internally of the seating (8), a variable response is achieved in the dissipation of kinetic energy during relative axial movement of the piston and cylinder.

25 5) A damper as in claim 1, comprising an annular friction element (9) of which the annular dimension is dissimilar to the virtual annular dimension of the seating (8) and the mean diameter (Ø9m) is different to

the corresponding mean diameter ( $\varnothing 8\text{m}$ ) of the seating (8), such that with the damper in operation, the friction generated through contact with the internal surface (S2) of the cylinder is greater than the friction generated through contact with the external surface (S3) of the piston.

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6) A damper as in claim 1 or 2 or 3 or 4, further comprising a membrane (31) fashioned in a material having a low coefficient of friction, interposed between the external surface (S3) of the piston and the corresponding internal surface (9a) of the annular friction element (9), of which the function is to reduce the relative friction between the two surfaces.

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7) A damper as in claim 6, wherein the low friction membrane consists in a film of paint applied to one of the two surfaces (9a, S3).

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8) A damper as in claim 6, wherein the low friction membrane consists in an ultrathin layer of material affixed to one of the two surfaces (9a, S3) with adhesives.

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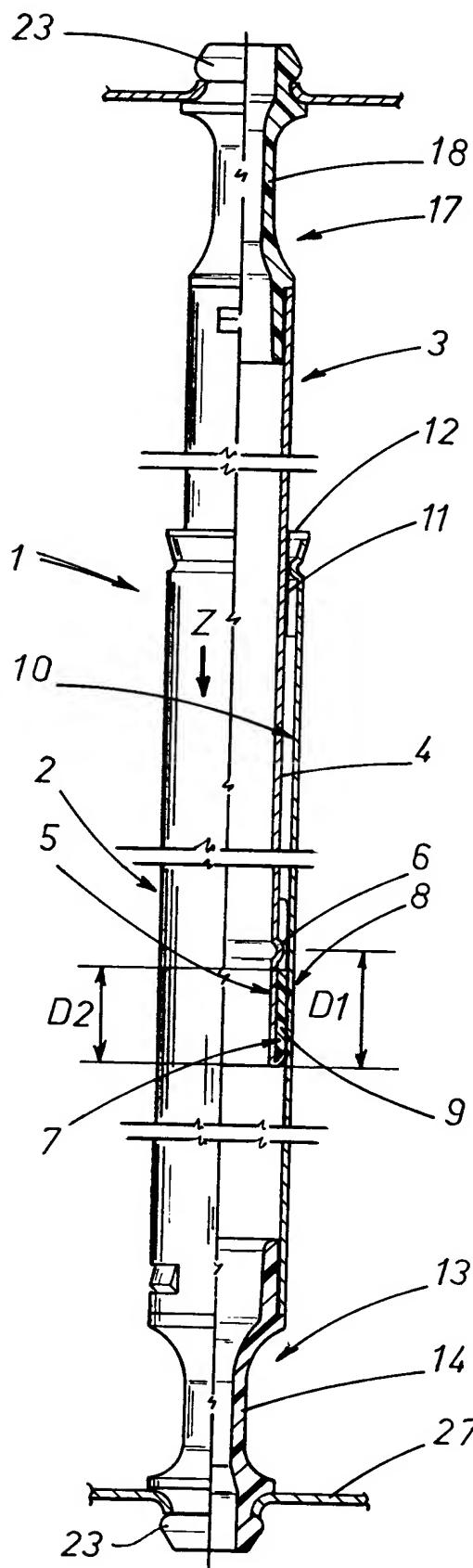


FIG 1

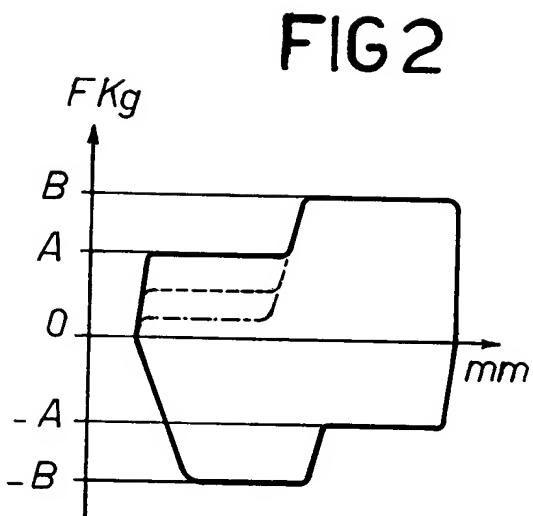
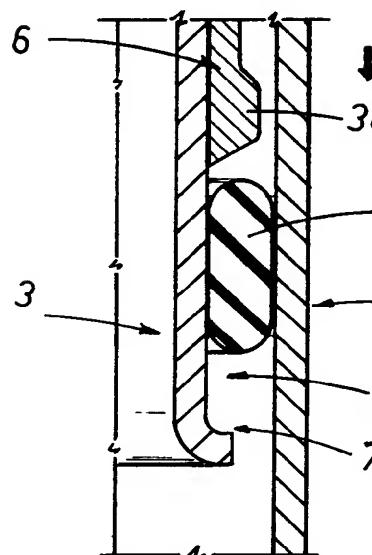
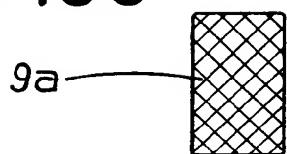
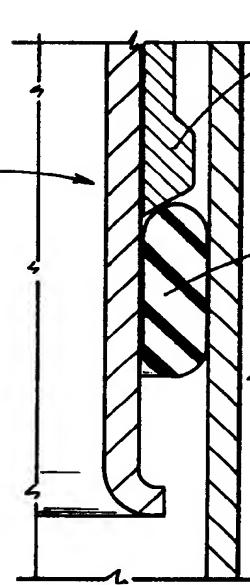
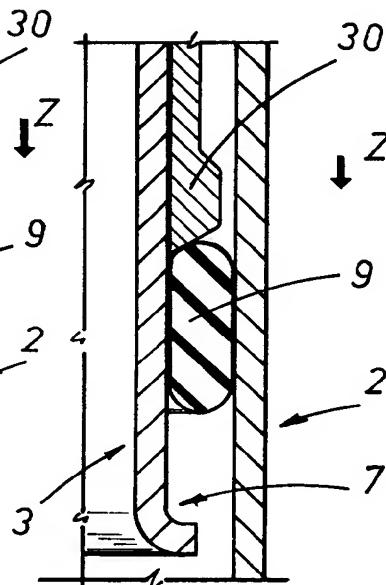
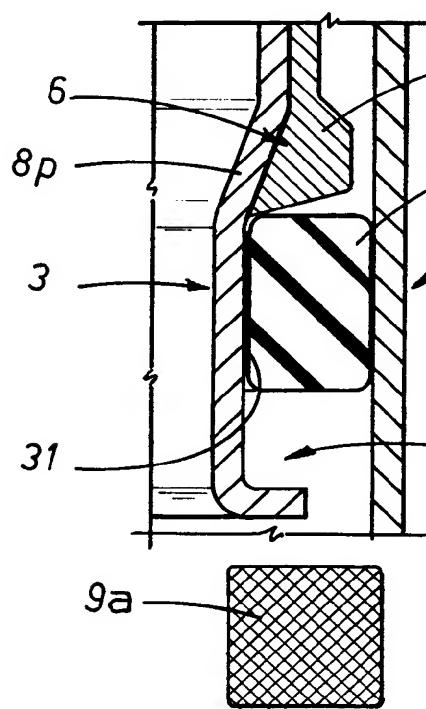
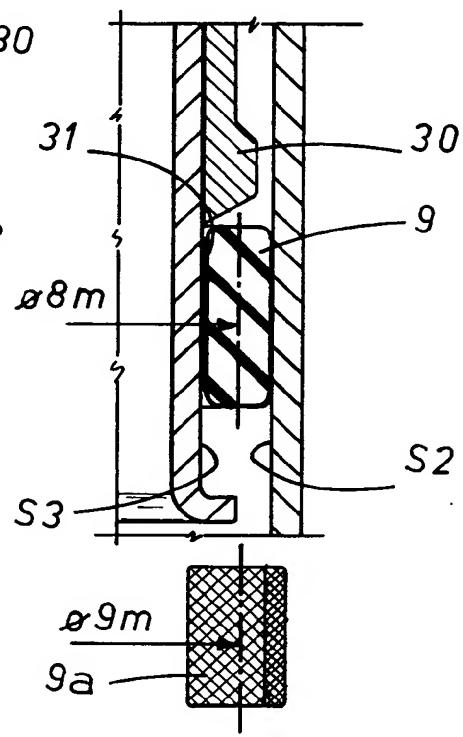


FIG 2

**FIG 3****FIG 4****FIG 5****FIG 6****FIG 7**



European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number

EP 92 83 0641

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	EP-A-0 407 755 (MIELE & CIE. GMBH & CO.CO.CO.) * column 2, line 36 - column 4, line 40; figures *	1,2,4,5	F16F7/08 D06F37/20
A	---	3,6,8	
Y	EP-A-0 301 190 (FRITZ BAUER + SÖHNE OHG) * column 2, line 17 - column 6, line 55; figures *	1,2,4,5	
A	---	6	
Y	PATENT ABSTRACTS OF JAPAN vol. 9, no. 187 (M-401)(1910) 3 August 1985 & JP-60 53 235 ( SHIYOUWA SEISAKUSHO K.K. ) 26 March 1985 * abstract *	1,2,4,5	
A	---	3	
A	US-A-3 796 288 (HOLLNAGEL) * column 1, line 58 - column 7, line 3; figures *	1,2,4,5	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
	-----		F16F D06F
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	17 MARCH 1993	VAN DER VEEN F.	
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document			

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**US-CL-CURRENT:** 68/23.1

**ABSTRACT:**

The damper (1) essentially comprises a cylinder (2) and, internally of the cylinder, a reciprocating piston (3) marginally smaller and substantially similar in overall section, of which the peripheral face presents a pair of annular projections (6, 7) serving to establish a seating (8) for an annular friction element (9) placed in direct contact with the inside wall of the cylinder (2); for operating purposes, the axial dimension (D1) of the seating (8) compassed by the two annular projections (6, 7) is greater than the axial dimension (D2) of the annular friction element (9) such that the damper produces a variable response in its dissipation of kinetic energy, the curve being determined by the difference (d0) between the external diameter (0e) of the

piston (3) and the internal diameter (0i) of the cylinder (2), and by the degree of relative axial motion between piston and cylinder.

